SOIL RESOURCE ASSESSMENT

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Santiago Fire

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Redacted Version Nov 28, 2007
This is a redacted version of this report. The treatment costs and addresses were removed from this report so bidding for any contracts for treatment implementation would not be influenced. The location of T & E species was removed to protect them from potential human disturbance.

Objectives

- Quantify erosion potential.
- Assess post-fire soil conditions, particularly those that pose substantial threats to human life, property, and soil productivity.
- Identify values at risk downstream and down slope from the high and moderate severity burn areas.
- Recommend treatments where appropriate.

The purpose of the post-fire assessment is to analyze fire effects on soils and watersheds, determine potential for negative effects, and consider possible treatment options. The potential threat to life and property are always the number one concern and is the first focus of the burned area assessment.

Initial Concerns

- Threats to human life and property within and downstream of the burn area from flooding and debris slides.
- Threats to soil productivity and water quality in severely burned areas.

Soil productivity, water quality, property, and life are potential values at risk when wildfire burns through an area followed by winter storms. The loss of natural vegetative cover allows water to runoff across bare soils with increased velocity. Fire also induces water repellency of varying degrees, reducing water infiltration, and increasing runoff. The net result under extreme conditions is a loss of soil, a loss of water control, and significant risk of flooding and debris flows downstream of the fire.

Resource Setting

The Forest Service BAER team did not assess the entire burn, however lands within the Forest congressional boundary were assessed. The Cal-Fire BAER team evaluated private ownership within the congressional boundary and all burned lands west of the congressional boundary.

This report surveys (rapid assessment) those watersheds inside the fire perimeter above the confluence of Silverado and Santiago and small portions of three watersheds on the southwest portion of the fire that drain to Trabuco Canyon (a total of 11,254 acres). The attached pdf file (appendix A) shows the "soil analysis area". It includes 6,701 acres of National Forest lands and 4,553 acres of private lands.

The communities of Modjeska and Silverado are located at the bottom of steep canyons. Because so much of the burn area is located upslope from the communities of Silverado, Modjeska, Williams and Trabuco, smaller subwatersheds were delineated to better assess the hazards to these communities.

The entire fire burned approximately 28,476 acres (6,701 acres occurred on the Trabuco Ranger District). The overall burn severity summary for the 28,476 acre Santiago Fire was 1,799 acres High, 8,184 acres Moderate, and 18,314 acres Low and Unburned. The general resource setting is described in appendix B. Relief, climate, and major soil types are briefly described.

Observation and Findings

The soil scientists worked with the hydrologists and geologists to evaluate post-fire watershed conditions. The burned area was surveyed by satellite imagery, helicopter reconnaissance, and ground survey to identify values at risk, soil burn severity and soil water repellency.

Summary Post-fire Soil Conditions

- The BAER Team assessment found the overall burn severity summary for congressional lands within the Santiago Fire to be 13% high, 45% moderate, and 43% low and unburned. See appendix C for soil burn severity criteria.

- The overall average erosion rate for congressional lands was 35 tons per acre. The erosion rate for the high and moderate burn severity areas was 58 tons per acre. In contrast, background erosion was estimated to be 2 tons per acre.

- Hydrophobic soil conditions varied with soil burn severity. Approximately 15% of the low burn severity area was strongly hydrophobic (0 to ¼ inch surface layer). 30% of the moderate burn severity area was strongly hydrophobic (0 to ¼ inch surface layer). 60% of the high burn severity area demonstrated strong water repellency from the soil surface to a depth of ½ to 1 inch. Low natural hydrophobicity was observed in unburned areas also.

Threats to Life and Property

The Team began a rapid ground reconnaissance BAER watershed survey on November 1, 2007 by investigating Modjeska Canyon area. Investigations were centered on identifying structures and facilities that could be at risk to flooding during high stream flows and potential debris flows. The Modjeska Reservoir located in Harding Canyon was completely filled with sediment after the 1969 flood event. The dam was built in 1919 and is approximately 45 feet high and about 120 feet wide. Sediment has built up behind the dam for about 1200 feet. Excavating the sediments behind dam was discussed as potential treatment with Orange County Flood Control and an Army Corp engineer during a November 7 meeting. This proved to be an unlikely treatment for a number of reasons. The reservoir still serves as a groundwater source for local residents. Several homes are located immediately downstream of the dam. The community of Modjeska is located immediately adjacent to the stream channel in a narrow confined valley with very steep side slopes. The one lane road into Harding Canyon has several bridge crossings.

On November 2, the BAER Hydrologists and Soil Scientists continued investigations in the Williams, Modjeska, Upper Silverado, Pine and Halfway watersheds. We encountered similar values at risk as in Harding and Modjeska Canyons. Specifically, structures located immediately adjacent to the stream channel in narrow, confined valleys with steep side slopes directly below areas of high and moderate burn severity.

On November 3, a helicopter flight was taken to recon the entire burn and to validate the BARC map (a burn severity map created from satellite imagery). November 4 the soil scientist and geologist reviewed photos taken during the recon flight and corrected the BARC map as necessary. The BARC map was accurate for the most part.

Another air reconnaissance flight was taken November 5 with BAER hydrologists and soil scientist. The objective for the flight was to validate the Burn Severity Map and further identify values at risk. The recon was concentrated in Williams, Harding, Modjeska and Silverado watersheds.

A meeting was held with the Orange County Public Works dept on November 7 (Engineering and Hydrology subcommittee). BAER hydrologists and soil scientists shared the predicted increases in flows and sediment draining from the burn area.

November 8 through November 10 was spent doing more ground recon, doing erosion modeling, and coordinating with BAER team members including the CalFire BAER team geologists. The CalFire geologists evaluated debris flow hazards on private lands. The FS BAER team presented findings and recommendations to the Forest Supervisor on November 10.

In the course of doing field work, the BAER team noted that debris flow deposits were common in various drainages through-out the burn. The importance of debris flow deposits is that they are direct evidence of a potential hazard zone. They are a geologic record of how far and where large amounts of mud and rocks have suddenly washed down a creek and come to rest. Typically there is no practical treatment for debris flows other than possibly deflecting the flow away from the value at risk or evacuating the hazard zone during large storms.

Debris flow deposits were noted in both large and small drainages. A portion of the floodplain within the community of Modjeska rests on a large debris flow deposit. Debris flow deposits are common in Williams and Pine Canyons. Small deposits were noted in the Live Oak-east fork channel immediately above the Hamilton Drive crossing (appendix D). See geology reports for a technical evaluation of debris flow hazards.

Threats to public road access in the burn area

The access roads (County and Private) in the communities of Modjeska, Harding, Williams, and Silverado that are located in and adjacent to the channel are at risk of flooding; subsequent bridge failures may occur during some storm events. The Hamilton Drive crossing is subject to flooding and sedimentation.

<u>Soil Productivity Threat</u>

The erosion that is expected to result from this fire is not judged to be an emergency relative to long term soil productivity. Erosion rates (58 tons per acre, 1st year) on moderate and high soil burn severity areas are considered very high, but may be still considered the normal pattern for this ecosystem and fire regime. However, fire adapted systems like chaparral recover quickly after fire. Native vegetative recover is expected within 5 to 7 years. Soil erosion rates will drop accordingly and is expected to be within background levels within 10 years. Tom White, Cleveland National Forest, has done some local monitoring and studies that would inform the soil productivity/ecosystem issue.

Fire is of course a natural occurrence in the ecosystem. For normal fires, the effects should be consistent with maintaining soil and productivity. Several factors may increase fire effects and create a need to provide soil protection. In some instances fires are unnaturally intense. Roads and trails can concentrate runoff and effectively increase the level of hillslope erosion. Hillslope treatments to prevent erosion and keep soil on hillslopes are the preferred alternative, along with treatments to manage water draining from roads and trails.

Results of Hydrologic Modeling

Erosion

The post-fire erosion risk was assessed using Rowe, Countryman and Storey (1949). Rowe, Countryman and Storey produced a classic study based on real data collected from many burned and unburned watersheds in Southern California. The Forest Service uses this model to estimate probable peak discharges and erosion rates from southern California watersheds as influenced by fire. Table 1 summarizes erosion rates within the fire perimeter by watershed. The table also gives both post-fire erosion and runoff rates times normal (pre-fire). See hydrology report for a more detailed analysis of runoff discharge.

Table 1: Hydrologic Response by watershed within the Santiago Fire
(Lands within Forest congressional boundary only-1st year erosion rates only)

Assessment Watersheds	**% of Watershed High & Mod Burn**	**Acres High & Mod. Burn**	**Sediment Increase from Burned Area Ac-ft**	**Erosion X Normal from Burned Area**	**Runoff X Normal** (Q_{10} storm-bulked)
Harding Ck	64	1949	55	21.1	5.3
Modjeska Ck	37	1810	51	19.5	3.5
Williams Ck	53	665	19	21.7	3.4
Santiago Ck	25	559	16	9.7	2.4
Upper Silverado	14	946	26.8	4.1	2.0
Assessment Sub-watersheds					
Upper Silverado					
Pine Canyon	68	322	9	24.2	5.5
Halfway Canyon	75	228	6.4	25.1	6.0
Shrewsbury Spring	51	168	4.7	24.8	4.3
Trabuco Canyon					
Aliso Canyon	18	439	12.9	13.8	2.2
Live Oak Canyon	11	117	3.4	12.6	1.7
Live Oak-east fork	42	51	1.5	12.6	3.9
Hickey Canyon	2	22	0.6	5.9	1.6

The model essentially erodes soil off the hillslopes into drainage ways, mobilizes sediment stored in the channels, and delivers the sediment to a point of interest or value. For example, where Harding Creek and Modjeska Creek come together within the community of Modjeska, the model indicates that approximately 100 ac-ft of sediment may be deposited the first winter, over the course of one or more storms. The model does not specify the size of storm. It is a probable output based on expected rates over a long period of time.

Discharge

Table 2 shows increases in discharge due to fire. Note that the runoff or discharge **increases greatly** with the storm size. Bulked discharge refers to storm runoff that is "bulked" by sediment. Several models were used to predict runoff, therefore a range is given for each return interval storm. The project file includes excel spreadsheets used to calculate the reported values. See hydrology report for a more detailed analysis of water runoff.

Table 2: Range of Predicted Discharges for 2, 10, and 50 -year return interval storms

Assessment Watersheds	**Post-Fire Q_2 Bulked Discharge (cfs)**	**Post-Fire Q_{10} Bulked Discharge (cfs)**	**Post-Fire Q_{50} Bulked Discharge (cfs)**
Harding Ck	383 – 797	1,110 - 4,513	1,825 - 9,345
Modjeska Ck	389 - 811	1,166 - 4,739	2,008 -10,279
Williams Ck	134 - 279	393 -1,596	655 - 3,352
Upper Silverado	275 - 574	8,93 - 3,630	1,704 - 8,721
Assessment Sub-watersheds			
Upper Silverado			
Pine Canyon	63 - 131	182 - 738	298 -1,524
Halfway Canyon	43 - 90	125 - 509	204 -1,042
Shrewsbury Spring	34 - 71	100 - 407	168 - 862
Trabuco Canyon			
Aliso Canyon	116 - 242	368 -1,497	684- 3,508
Live Oak Canyon	39 - 81	130 - 530	256- 1,313
Live Oak-east fork	11 - 22	32 - 128	54 - 275
Hickey Canyon	40 - 83	134 - 546	269 -1,379

Emergency Determination

Threats to Human Life and Property: Based on expected watershed response there **is an emergency** threat to life and property.

Table 1 and 2 summarize hydrologic response by watershed. The watersheds with the highest response are Harding, Modjeska, and Williams (large watersheds with significant percent of high and moderate burn). The sub-watersheds listed in Upper Silverado will have a very high response commensurate with their smaller size. Live Oak canyon above Hamilton Drive will also have a relatively high response. The Live Oak-east fork drainage is a small drainage that is geologically active (high incidence of debris slide and debris flow activity) and therefore may produce higher outputs than what the tables suggest

Several high risk areas were identified by the BAER watershed assessment team and they include:

- Residents and structures in immediate proximity to streams in the Modjeska, Harding, Williams, Pine and Halfway Canyons face increased risk from flooding and debris flows during high intensity rainstorms. Residences in upper Live Oak Canyon are also at increased risk.

- Debris flows in Modjeska, Harding, Williams, Pine and Halfway Canyons could potentially create temporary dams in drainage bottoms which, when filled with water and then breach, can cause dangerous flooding downstream.
- Access roads (County and Private) in the communities of Modjeska, Harding, Williams, and Silverado are at risk of flooding and subsequent bridge crossing failures. The Hamilton Drive road is also at risk of flooding.

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<u>Treatments to Mitigate the Emergency</u>

<u>Aerial Hydromulching</u>

There is an opportunity to reduce the expected increases in peak flows and sediment yield by hydromulching moderate and high intensity burn areas where slopes are less than 50%. This treatment has been used most recently by the Forest Service on the Angora Fire (Lake Tahoe) and the Cedar Fire (San Diego). There are approximately 1750 such treatable acres on national Forest land. This treatment is expected to reduce runoff and sediment routed to flood-prone areas. A wood and paper mulch matrix with a non water-soluble binder will be applied to Forest Service land in the upper portion of the watersheds. This treatment will provide immediate ground cover to help reduce flood peaks and sediment yield downstream in the communities of where there are lives and high values at risk. Mulch will be applied as a slurry by helicopter and/or fixed wing aircraft. (Note: Helimulching with dry straw, though less costly than aerial hydromulching, was considered but discounted because it would not likely remain in place due to winds in the area).

The hydrology report (tables 9-11) quantifies the reduction in discharge expected with the hydromulch treatment. Potential reduction in erosion rates following treatment is displayed in table 12. The report states that using Santiago Creek upstream of gauge as a representative site, flow reduction estimates range from 25-27% for a Q_{10} storm. Reduction in sediment yield is within a similar range. See hydrology report for assumptions used in the modeling.

It is unlikely that hydromulching would be effective at the 25, 50 or 100-year return intervals because the flow magnitudes are too great. In other words, people living downstream are **still at risk** and there is no guarantee that treatment will protect life and property during a large storm event.

Early Warning System: Flood-warning systems, commonly called early-warning systems (EWS), are installed in burned watersheds on Forest Service lands. EWS provide local emergency networks, such as police, fire, or emergency preparedness organizations with information on rainfall intensity and duration allowing early detection of hazardous conditions. The National Weather Service is responsible for setting thresholds relative to precipitation and issuing flashflood warnings. The Forest Service is typically involved with procuring and locating the EWS. The local emergency network maintains the EWS. The Orange County Flood Control Agency will have more information.

Removal of Floatable Debris

Live Oak-east fork above Hamilton Drive. Recommend removing both the pipe and the downed oak tree from the channel and placing in safe location on Forest Service lands or hauling away. More follow-up needs to be done to determine how best to do this. If a small Sweco trail machine is used to put in waterbars on the Moro trail (also locally known as the Luge trail) the machine can drag out the pipe and sections of the tree. **The Forest Service implementation team can look at the situation and modify treatment accordingly**. Costs are expected to be $XXXX.

Discussion/Summary/Recommendations

Slope treatments were considered for sites with higher erosion risk. One potential slope treatment is seeding. There are several factors which must be considered in an analysis of post-fire seeding (adapted from the Los Padres National Forest seed policy letter). Some of the seeding criteria are:

- No seeding on grasslands and oak/grass woodlands
- No seeding on steep slopes (preferably less than 50%)
- No seeding on low burn intensity areas
- No seeding on areas where vegetation cover after two years is expected to be 30% or greater
- No seeding on poor sites

Applying these seeding criteria to the Santiago Fire eliminates most of the area from consideration for seeding. Much of the area is steep and rocky and unsuitable for seeding. Most of the area is covered in various chaparral vegetation types that are expected to recover to greater than 30% cover within two years.

Seeding alone has become less popular as a treatment due to its limited effectiveness and impacts on native plant communities. In a review of existing studies on seeding, few studies demonstrate statistically significant decreases in sediment movement (Beyers, 2004). In addition, seeding rarely provides any effective cover the first year after the fire. This is especially true in areas of low rainfall and poor soils.

Further information on the BAER program can be found in the references under USFS BAER website.

References

Beyers , J.L. 2004. Postfire seeding for erosion control: effectiveness and impacts on naïve plant communities, Conservation Biology 18 (4), 947-956.

Parsons, A. (2002). Mapping Post-Wildfire Burn Severity Using Remote Sensing and GIS. Proceedings, ESRI User Conference 2002, San Diego, CA

Rowe, P.B., C.M. Countryman and H.C. Storey. 1949. Probable peak discharges and erosion rates from southern California watersheds as influenced by fire. U.S. Department of Agriculture, Forest Service. California Forest and Range Experiment Station.

USFS BAER Web site: http://fsweb.gsc.wo.fs.fed/baer
USFS BAER Handbook FSH 2509.13 (see it on the USFS BAER web site)
USFS BAER Manual FSM 2523 (see USFS BAER web site)

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Appendix B

Resource Setting-General

Geology – The geology of the burned area is described in the geological assessment report.

Relief – Slopes are generally steep inside the fire perimeter. The steepest slopes are found in Harding, Modjeska, Pine, Halfway Canyons and Shrewsbury Spring watersheds. More than 40% of these watersheds have slopes greater than 50%

Climate –. The mean annual rainfall is estimated at 24 inches and occurs primarily in the winter months. However, rainfall is highly variable from year to year and the recorded high was 72 inches falling in one year.

Rainfall and storm intensity are important determinants of soil erosion The two year 3.5 hour storm is a frequently occurring and high intensity storm that is representative of annual rainfall erosivity. The two year 3.5 hour storm intensity for the fire area is estimated to be 1.6 inches.

Major Soil Map Units - The major soil map units are listed in the table below. Descriptions of the soil units may be found in the Cleveland National Forest Soil Survey.

Map symbol	Map unit name
153	Rock Outcrop
	152 Exchequer – Rock outcrop complex 30 to 75 percent slopes
118	Blasingame stony loam, 30 to 65 percent slopes
108	Anaheim clay loam, 15 to 30 percent slopes
109	Anaheim clay loam, 30 to 50 percent slopes
134	Less sloping soils

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Appendix C

Burn Severity Criteria
Parsons, A. (2002)

FSH 2509.23.31,32 contains guidelines discussing site indicators to use in determining these classes. The Interagency BAER/ESR Handbook also contains some definition guidelines. Keep in mind that these are only guidelines, and each fire/ecosystem situation can be different. You may observe other characteristics that will help you determine how to map a given area. Develop familiarity with the specific ecosystems of your burned area, and learn to judge characteristics that indicate the level of burn severity.
There are some relatively minor differences in the various class definitions that the Handbooks endorse. Become familiar with them and work with your team leader to decide what makes sense to use in your area. In general, the guidelines can be summarized as follows:

UNBURNED; This one is obvious. The polygon has not been burned.

LOW; The majority of the polygon has not been significantly altered by the fire. Significant amount of remaining intact or singed leaf litter and duff remain, ash is sparse, small unburned fuels remain, canopy is largely intact, grass and shrub root crowns are intact. Areas where pre-fire vegetation was sparse, and/or bare soil and rock fragments dominate should be classified as Low severity, since there was little fuel to burn to begin with. Low severity burn areas do not contribute to an emergency watershed condition, but they may act as buffer areas to mitigate flood hazards that originate on more severely burned areas. Overstory mortality is generally minimal but can be significant in some cases.

MODERATE; This class is the most difficult to define, but think of it as intermediate between LOW and HIGH. Its specific characteristics may vary depending on the ecosystem types involved in the fire area. Less than 40 percent of the area exhibits high severity characteristics. During triage, areas of MODERATE severity are not as likely to be prime candidates for emergency stabilization treatments, but a rating of moderate alerts the team to the possibility that the area may be a potential flood source area. The site is somewhat altered by fire. Overstory mortality may be moderate to high, where brown needles remain but trees are dead.

In forested areas, generally litter is consumed and duff deeply charred or consumed, but recognizable char and some unburned remnants of leaf or needle litter and duff may remain. Ash and char are present. Soil characteristics are not significantly visibly altered. Fine and very fine roots and soil structural aggregates are still intact in the soil surface. On shrub or grassland sites, canopy is consumed and ash may replace the usually sparse pre-fire leaf litter. Evidence of unburned litter is found under a thin ash or char layer. Shrub skeletons remain but leaves and fine twigs are consumed. Water repellency may be observed in places, but other factors such as remaining ground cover or needle cast potential, or rapidly resprouting vegetation will help to mitigate runoff to some extent. Generally, runoff response is significantly accelerated as a result of the fire for the first year only on moderate severity shrub sites. Runoff in subsequent years is mitigated by vegetation recovery.

A situation that often causes confusion in burn severity mapping is an area where you may find forested areas where duff and litter have mostly been consumed, but small fuels and needles remain in the canopy. Even though these needles may be brown and dead, they will quickly fall and create a natural mulch, or ground cover. This natural mulch will act to moderate soil surface temperature and moisture, add native organic matter, and protect the soil from raindrop splash and runoff. Replenishing ground cover is the least expensive and single most effective treatment we can implement on a burned area, and during triage for treatment recommendations, these areas with natural mulch potential are not likely to be high priority for treatment. It will usually be classified as “Moderate”, especially if you can identify intact soil structure or fine roots, and at least some remnants of charred duff and litter.

HIGH; The site has been significantly affected by the fire. In general, areas where pre-fire vegetation, ladder fuels, and litter layers are thick, heat residence time is often long. More than 40 percent of the area exhibits characteristics of high severity. The area is classified as high burn severity if duff and litter layers have been completely consumed to ash such that little or no effective ground cover remains, surface soil is often loose, single grained with little sign of intact structure or fine roots. (It is important to compare to unburned areas, since sometimes this is the natural condition.) Soil structure is often destroyed, and fine roots in surface soil have been consumed. Surface soil which, prior to the fire, may have had stable granular structure can, after a high severity burn, be loose and single grained, due to volatilization of roots and binding organic compounds. Water repellency may or may not be significant, but is often increased after a high severity burn. (Water repellency alone is not necessarily an indicator of high severity, nor is it required for a classification of HIGH severity.) Use multiple indicators rather than just one or two. The size of fuels remaining is generally large - all fine fuels have been consumed. In other words, the only stuff remaining is big stuff. The soil hydrologic function has been significantly altered. Little or no ground cover or litter remains, and trees are black sticks with no needlecast/mulch potential. Runoff and erosion will be significant. Canopy and small to medium or even large fuels are usually consumed. Natural recovery of vegetation may be inhibited. Overstory mortality is generally high, up to 100%.

The appearance and characteristics of HIGH severity may vary from ecosystem to ecosystem, thus it is difficult to give a hard and fast definition. Sometimes ash color can indicate heat of consumption; white ash may indicate more complete consumption, but some vegetation species tend to produce white ash as well, so ash color by itself is not a reliable indicator. Plenty of areas with black or gray ash are high severity. Grass or shrub root crowns may have been consumed and natural resprouting and revegetation may be inhibited.

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Appendix D

Subject: Field observations in Live Oak Canyon above Hamilton Drive.

November 10, 2007 I met with one home owner, XXXXXXXXXX, and Bob Hewet (NRCS field staff). FS geologist Dr. Tom Koler looked at this area earlier and asked me to look at the potential for soil erosion and flooding in the watershed. CalFire geologists also looked at this area with Koler.

Two houses are located in the watershed referred to as Live Oak-east fork. The burned watershed above the residences is Forest Service. It is obvious that this watershed is characterized by very steep geologically unstable slopes that are essentially "untreatable". Hydromulching is not an effective treatment in the east fork of Live Oak.

Observations and Findings

1. A debris slide was noted on Forest Service lands immediately above one of the Live Oak-East Fork residences. Koler said the house is built on the toe of the slide. The head wall of the slide is located approximately 600 feet slope distance from the house. Slope of the head wall is 60-65%. Two smaller slides are "nested" within the head wall and bowl area. The natural drainage slopes in a concave profile from 40% below the head wall to 25% and flattens to 15-20% at the toe of the slide. The house sits on a horizontal pad cut into the toe. Soil texture is noted as a silty clay loam which infers a high erosion hazard and propensity to slump after absorbing water. The 1998 storm brought mud down on the house. The NRCS staff discussed treatments designed to control water off the slide area and on to the house pad. I suggested that NRCS staff should coordinate with CalFire and FS geologists to determine if the fire has increased the risk of debris slides targeting the house. If this is the case, NRCS may present an alternative treatment.
2. Small debris flow deposits were found within the channel above the Hamiliton Drive crossing. The crossing has a 4 foot culvert (no wing wall). NRCS staff recommended a trash rack in front of the culvert. In 1998 the culvert plugged and backed up water in the channel for 100 feet. Sediment was deposited on the road. The channel at this point has a good capacity for containing small debris flows. Debris flow deposits were noted upstream from the house built on the toe of the slide. The channel becomes narrow at this point (at the fence line) and is a natural place for sediment to deposit. Channel grade stays at 5% for some distance and steepens to approximately 10% in the upper half of the watershed. Two concerns were noted in the channel above the fence line (Forest Service lands). Immediately above the fence line was a CMP pipe located in the

channel but weakly supported by soil not yet washed away. The concern is that this could become floatable debris in a large storm event. Also noted is a downed oak tree in the middle of the flood channel a short distance upstream (potentially floatable debris or a possibly plug if floated down to where the channel narrows at the fence line). Recommend removing both the pipe and the downed oak tree from the channel and placing in safe location on Forest Service lands or hauling away. More follow-up needs to be done to determine how best to do this. If a small Sweco trail machine is used to put in waterbars on the Moro trail (also locally known as the Luge trail) the machine can drag out the pipe and sections of the tree. The Forest Service implementation team needs to do this. Costs are expected to be $XXX.

3. This is a small watershed relative to other areas in the fire. However, the steep geologically unstable slopes through-out the watershed may put an inordinate amount of material in the channel and therefore may present a higher risk of sedimentation downstream than what can be calculated using an erosion model. See geology report for more technical analysis or recommendation.

4. A discussion with homeowner XXXXXXX brought forward information concerning other potential values at risk in the Hamilton Drive area. The homeowner stated that 7-8 houses were within half a mile downstream of the culvert crossing on Hamilton Drive and located in the floodplain. He said that if the culvert is washed out 25 houses are impacted and have no exit. He also stated that a house on XXX Hamilton Trail is located in a poor place and needs to be assessed.